IEC-625/IEEE488 Bus Interface PM 9696

Operating manual

9499 460 12211
Fourth edition

PHILIPS
Industrial &
Electro-acoustic Systems

PHILIPS

Important

As the instrument is an electrical apparatus, it may be operated only by trained personnel. Maintenance and repairs may also be carried out only by qualified personnel.

Please note

In correspondance concerning this instrument, please quote the type number as given on the type plate.

⚠

The instrument is marked with this symbol when it is necessary for the user to refer to the manual.

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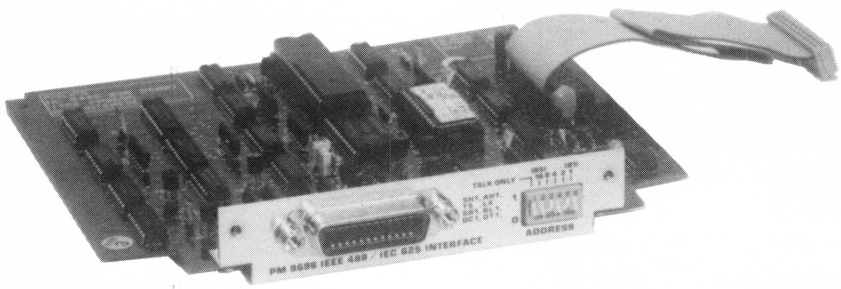

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1. INTRODUCTION

The talker/listener interface board PM 9696 is an IEEE-488/IEC-625 BUS interface, for use in the frequency counters and timer/counters of the PHILIPS PM 6670-series and in the timer/counters PM 6652,-54. It fully meets the requirements of IEC-625-1 and IEEE-488 as regards hardware. It also fully meets the requirements concerning codes and formats according to IEC-625-2 and IEEE-728.

When ordered simultaneously with a counter, this interface is supplied factory installed, but is available to order as a separate option for field installation.

It allows the counters fast and versatile communication in automatic test systems. All functions of the PM 6652,-54 are programmable via the interface bus, and all major functions of the PM 6670-series.

With the IEEE-interface option installed, the counters are suitable for many applications where computer processing of measuring data and/or communication with other instruments are required. Some examples are:

* Automated production testing
* Quality Assurance testing
* Research and development instrumentation clusters
* Processing of measuring data
* Automatic performance check of the counter
* Educational fields

NOTE: This manual describes the use of the interface board in a PM 6670-series counter or timer/counter. The operating instructions for the interface board used in a PM 6652,-54 are found in the PM 6652,-54 Operating Manual.

Other publications concerning the PM 9696 are:

Pocket Guide for PM 6670 series	9499 460 12011
Pocket Guide for PM 6652,-54	9499 460 11111
PM 6652,-54 Service Manual (Contains service instruction with signature analysis)	9499 465 00511

2. SAFETY INFORMATION

Read this page carefully before installation of the interface in the instrument. The interface described in this manual is designed to be used by properly trained personnel only. Adjustment, installation or maintenance and repair of the exposed equipment shall be carried out only by qualified personnel who are aware of the hazards involved.

Safety precautions

For the correct and safe use of the instrument, in which this interface is fitted, it is essential that both operating and servicing personnel follow generally accepted safety procedures in addition to the safety precautions mentioned in this manual.

Impaired safety operation

Whenever it is likely that safe operation is impaired, the instrument must be made inoperative and secured against unintended operation. The appropriate servicing authority must be informed.

3. CHARACTERISTICS

Safety characteristics

This instrument in which the interface is to be fitted, has been designed and tested in accordance with IEC Publication 348, Safety Requirements For Electronic Measuring Apparatus For Class 1 instruments, and has been supplied in a safe condition. This manual contains information and warnings that should be followed by the user to ensure safe operation and to keep the instrument in a safe condition.

Performance characteristics

Properties expressed in numerical values with stated tolerances are guaranteed by the Philips organisation in your country. Specified non tolerance numerical values indicate those that could be nominally expected from the mean of a range of identical instruments. This specification is valid after the instrument has warmed up for 15 minutes. (Reference temperature 25 °C.)

Interface Functions

The bus-interface functions are listed in Table 3.1, together with information regarding the PM 9696 interface capability.

NOTE: Where there might be confusion between the letter O and the digit O, the digit is written Ø.

Description	Code	Capability
Source handshake	SH1	Complete
Acceptor handshake	AH1	Complete
Control function	CØ	No controller
Talker function	T5	Complete
Listener function	L4	Complete (except listen only)
Service request	SR1	Complete
Remote/local function	RL1	Complete
Parallel poll	PPØ	No parallel poll
Device clear function	DC1	Complete
Device trigger function	DT1	Complete

Table 3.1 Summary of interface functions.

Source and Acceptor Handshake (SH1, AH1) simply indicates the facility to exchange data between the counter and other instruments or a controller.

Talker Function (T5) means that the counter can communicate its measuring results to other devices or to a controller ("it talks"). T5 also means that the counter can send out a status byte as a response to a serial poll, performed by the controller.

Listen Function (L4) means that the counter is capable of receiving programming instructions from a controller ("it listens").

Service Request (SR1) means that the counter can interrupt the controller, e.g. after completion of each measurement. The counter effectively says to the controller "Hi there! Listen! I've got something for you".

Remote/Local (RL1) means that the counter can be controlled manually (local) or remotely via the bus.

Device Clear (DC1) means that the counter can be remotely reset and forced to default settings.

Default settings are: FREQ (F15 or F1), H0, T0, G0, A, S0, M30E-2.

Device Trigger (DT1) means that you can remotely start (trigger) a new measurement via the bus.

Table 3.1 contains all the interface function subsets according to IEC-625. For many of the functions there are only two alternatives. Function is present or not present. That is the case for SH, AH, SR and DT. A non-present function is identified with a "zero" after the function code (e.g. SRØ) and a function present is identified with a "one" (e.g. DT1).

Other functions may be implemented in different versions. There are nine Talker functions (TØ...T8) and five Listen-functions (LØ...L4). In PM 9696 the talker function T5 and the listen function L4 are included.

The talker function T5:
* Talk-only mode
* Serial poll
* Automatic unaddressing when addressed as listener.

The listener function L4:
* Basic listening.
* Automatic unaddressing when addressed as talker.

Address selection

All devices on an IEEE-488 bus must be assigned a bus device address. The counter address is selectable by the five right-hand switches on the rear panel address-selector switch. All addresses except 31 ($=11111_{BINARY}$) are allowed. On delivery the selected address is 10 (01010_{BINARY}). By setting the left switch (TALK ONLY) in position 1, the counter will not be addressable. TALK-ONLY mode is used when measuring data is to be transmitted directly to a listener, without any controller involved. A counter (talk-only) can for example be directly connected to a printer (listen only), for continuous registration of counter data. Talk-only mode must never be used in bus configurations that include a controller. Talk-only mode implies that the counter is no longer capable of "listening" to a controller.

If the counter by accident is switched over to talk-only mode, the bus will be permanently blocked, and no other instrument will be able to "talk" on the bus.

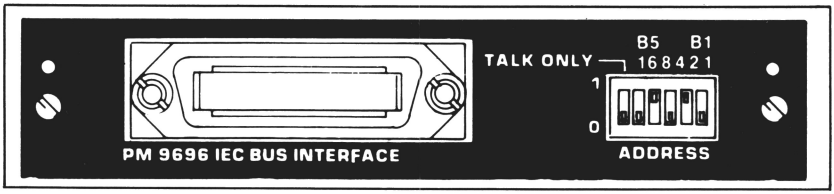


Fig. 3.1 Bus Interface panel

Device Functions — Input Data To Counter

The counter is instructed to perform various measurements when it receives appropriate programming codes (the counter is "listening" to the controller).

The programming code is a string of one or several ASCII-characters, see Chapter 7. The first character is always alphabetic, and the string is terminated by a delimiter sent out from the controller.

Input delimiters

The PM 9696 interface accepts five different input delimiters, and thus has maximum flexibility for adaptation to virtually all types of controllers. The input delimiters recognized and accepted are:

LF	(Line feed	code $0A_{HEX}$	
CR	(Carrige return)	code $0D_{HEX}$	
ETX	(End of text)	code 03_{HEX}	
ETB	(End of transmission block)	code 17_{HEX}	
,	(Comma)	code $2C_{HEX}$	
;	(Semicolon)	code $3B_{HEX}$	*

*) Only programs of revision 03 and higher.

Programming code format

Numerical values can be represented according to all three standardized (IEC-625-2) formats NR1, NR2 or NR3.

NR1: Integer value (without decimal point)
NR2: Scaled (with floating decimal point)
NR3: Exponential notation with floating decimal point and exponent. Preferred exponent values are multiples of ±3. However, the counter also accepts other exponent values than multiples of ±3.

Example: A measuring time of 1.5 s can be represented as M1.5, M15 E-1 or M0.015 E2.

If a programming string contains programming of several functions, e.g Period measurement (code F13), Hold-off active (code H1), Measuring time 2 s (code M2), the different programming codes can be separated by commas (F13,H1,M2), by spaces (F13 H1 M2) or not separated at all (F13H1M2). Spaces can be inserted anywhere in the programming string, e.g F 13 H 1 M 2.

Programming codes

The programming codes are shown on the next page in Table 3.2. Note that frequency A measurements for PM 6673...76 can be performed in three different ways.

a) Automatic choice of reciprocal mode (below 10 MHz) or conventional mode (above 10 MHz), code F1.
b) Always conventional mode, code F5.
c) Always reciprocal mode, code F1G1.

The timer/counters PM 6671...72 always use reciprocal frequency mode.

NOTE: Only upper case letters are accepted by the interface if program revision 2 is fitted. Programs of higher revision accept both upper and lower case letters.

Functions	Programming code PM 6671...72	PM 6673...76
COUNT A (manual)	F9	FØ
COUNT A Start/Stop by B	F4	
COUNT A Gated by B	F2	
FREQUENCY A	F15	
FREQUENCY A, Normal		F1
FREQUENCY A, Conventional		F5
FREQUENCY A, Reciprocal		F1G1
FREQUENCY B or C	F15C	F1B
PERIOD A	F13	F10
PHASE A-B	F3	
PULSE DURATION A	F12	
RATIO A/B	F7	
RATIO A/D or B/D		F8A or F8B
RPM	F14	
TIME INTERVAL A-B Single	F6	
TIME INTERVAL A-B Average	F11	
HOLD OFF - On	H1	
HOLD OFF - Off	HØ	
Input A	A	A
RF Input, B or C	C	B
FREQ A AVERAGE	G1	
ARMING or EXT RESET	GØ	
Single measurements	T1	*
Repetitive measurements	TØ	
Measuring time	M-----	**
Trigger (start meas.)	X	
Device clear ***	D	
Program data out ****	P	
Service request disable	SØ	
Service request enable	S1	

Table 3.2 Programmable controls and functions.

*) For program rev. 02, phase does not work with T1. I.e. the meassurement will start directly without waiting for 'X' or 'GET' even if T1 is selected. For program rev. 03, T1 will work but only with 'X'.
Count A will not work with T1.

**) The measuring time and function can be sent in any of the standardized formats NR1, NR2 and NR3. Allowed characters are: digits, +, -, and E.

Example: M3ØE-2 will give a measuring time of 0.3 s. The measuring time range is 0.01 s to 99 s.

***) Device clear (or power on) will program the counter in default position, which is FREQ (F15 or F1), HØ, TØ, GØ, A, SØ, M3ØE-2.

****) When P (program data out) is sent, the counter will return information about programmed functions and measuring time etc., instead of measuring data.

Example: Data sent as "F13,HØ,T1,G1,A,SØ, M3ØE-2".

Device Functions — Output Data From Counter

The result of a measurement is transmitted to the controller over the bus. The counter is "talking". The output data from the counter can be of three different kinds.

a) Status message string
b) Status byte
c) Normal measurement values

A status message string, is a string of 25 ASCII-characters, defining the present programming of the counter (software information). It is sent out instead of a measurement value when instructed to do so by programming code "P" (Program data out), see Programming codes for details.

A status byte is a one-byte message sent out by the PM 9696 interface as a response to a serial poll. The status byte contains hardware information such as:

a) Service requested by the counter? Yes/No
b) Error condition? Yes/No
c) Counter is busy or ready for new measurement.

A normal measurement result is sent out as a string of ASCII-characters according to the following format:

F	F	0 SP	X	X	X	X	X	X	X	X	X	X	E	±	X	D	(D)

Bytes 1,2: FF = Function code, see Table 3.3.
Byte 3: Normally a space character. On overflow an 0 is sent.
Byte 4...13: XXXXXXXXXX means ten characters containing the measurement value. Nine characters are digits and one is a floating decimal point.
Byte 14: E is exponent pointer.
Byte 15: Exponent sign is + or -.
Byte 16: Exponent value X is either Ø or multiples of ±3.
Byte 17: Delimiter CR, LF, ETX or ETB.
Byte 18: Second delimiter LF, only if delimiter combination CR+LF has been selected.

Function codes

Functions	PM 6670...72	PM 6673...76
Count A, manual	CA	CA
Count A, gated by B	CB	
Frequency A	FA	FA or FR *
Frequency B or C	FC	FB
Measuring time **	MT	MT
Period A	PA	PA
Pulse width (duration)	PD	
Phase	PH	
Ratio A/B	RA	
Ratio A/D or B/D		RA or RB
RPM	RM	
Count A, start/stop by B	SS	
Time Interval average	TA	
Time Interval single	TI	

Table 3.3 Function codes.

* FA indicates conventional frequency mode and FR indicates reciprocal mode.

** Measuring time "MT....." is sent out only under the following conditions:

a) Counter is in local mode.
b) Measuring time pushbutton is pushed.
c) Controller requests data from counter.

Output Delimiter

The delimiter can be programmed with two jumpers on the circuit-board to be either CR, LF or CR+LF; see Table 3.4.

Setting	TØ	T1
LF	LF	LF+EOI
CR	CR	CR+EOI
CR+LF	CR+LF	CR+LF+EOI
-	ETB	ETX

Table 3.4 Delimiter settings

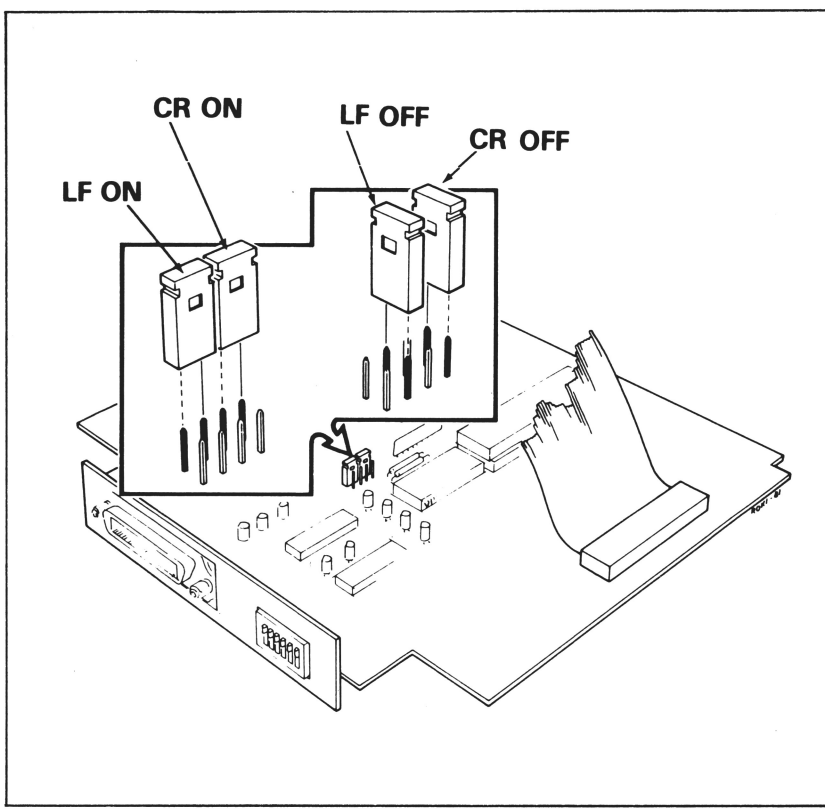


Fig. 3.2 Programming jumpers control the output delimiters

Status byte

The status byte can have ten different values, corresponding to ten different status modes of the counter. The following format is used:

Bit 8 : Always Ø
Bit 7 : Service request has been sent (1) or not (Ø)
Bit 6 : Error condition (1) or not (Ø)
Bit 5 : Counter is busy (1) or ready (Ø)
Bit 2 : Main gate open (1) or closed (Ø)
Bit 1-4 : Counter status specification.

A Service request is sent out on two conditions:

a) If there is an error.
b) After each measurement if SR1 has been programmed.

These two conditions correspond to status byte codes 01100000 and 01000000 in Table 3.5.

An error occurs if the counter is wrongly programmed, e.g. false programming code, measuring time out of range, etc. In this case the counter will be set to corresponding default values. An attempt to program function F49 will result in FREQ A measurement (default function). An attempt to program 1 µs measuring time will result in 0.3 s (default), etc. The counter is busy during the actual measurement and also during the preparation for the measurement. The counter is ready when the result is ready for output on the bus. A normal measurement cycle consists of the following phases:

a) Preparation of measurement.
b) Waiting for input signal synchronization to start.
c) Measuring during the set measuring time.
d) Waiting for input signal synchronization to stop.
e) Processing the counting register data.
f) Output of the correct result.

The status byte codes for the above phases are shown in Table 3.5. Note that both the preparation phase and the output phase have two different codes depending on whether repetitive measurements (programming code TØ) or single measurements (T1) have been selected. After an error, a service request (bit 7) is sent. Before the new preparation is made, bit 7 changes from 1 to Ø, i.e. the status code is 32 (00100000) for a moment.

Status Message	Binary	Decimal	
Preparation (T1)	00010000	16	
Preparation (TØ)	00011000	24	
Waiting for start sync.	00010011	19	Busy
Measuring	00010100	20	
Waiting for stop sync.	00010101	21	
Computing	00010001	17	
Ready for output (T1)	00000000	0	
Ready for output (TØ)	00001000	8	Ready
Ready, with service req.	01000000	64	
Error, - " -	01100000	96	

Table 3.5 Status byte messages.

Bus Drive Data

Output connector:	IEEE recommended type Amphenol 57 series "Micro ribbon"
Output:	E1 (Open collector)
Output voltages:	High: above 2.5 V Low: below 0.4 V at 48 mA
Input:	Hysteresis, typically 0.8 V Input high: above 2.0 V Input low: below 0.6 V
Termination:	Resistance 3.3 kohm ±5% (to 5 V) 6.2 kohm ±5% (to earth) Capacitance Below 100 pF
Power requirements:	Supplied from counter; adds 0.7 W to counter power consumption.
Dimensions and weight:	wxhxd 190x25x155 mm, weight 250 g
Temperature:	Operating 0...+50 °C Storage -40...+70 °C
Humidity: (no condensation)	Operating 10...90 %RH Storage 15...95 %RH
Altitude/Barometric pressure:	Operating 5000 m/53.3 kN/m Storage 15000 m/15.2 kN/m
Mechanical type-test:	
- Vibration:	According to IEC 68 Fc
- Bump:	According to IEC 68 Eb
- Handling:	According to IEC 68 Ec
- Transport:	According to NLN-L88.
Accessories:	A plastic bag with accessories is supplied with the bus interface. The bag includes a mounting set and a PM 9696 label.

4. INSTALLATION

The mounting set in the accessory bag includes brackets and screws for securing the bus interface inside the counter.

- Remove the top and bottom cover from the counter
- Remove the cover plate at the rear of the counter

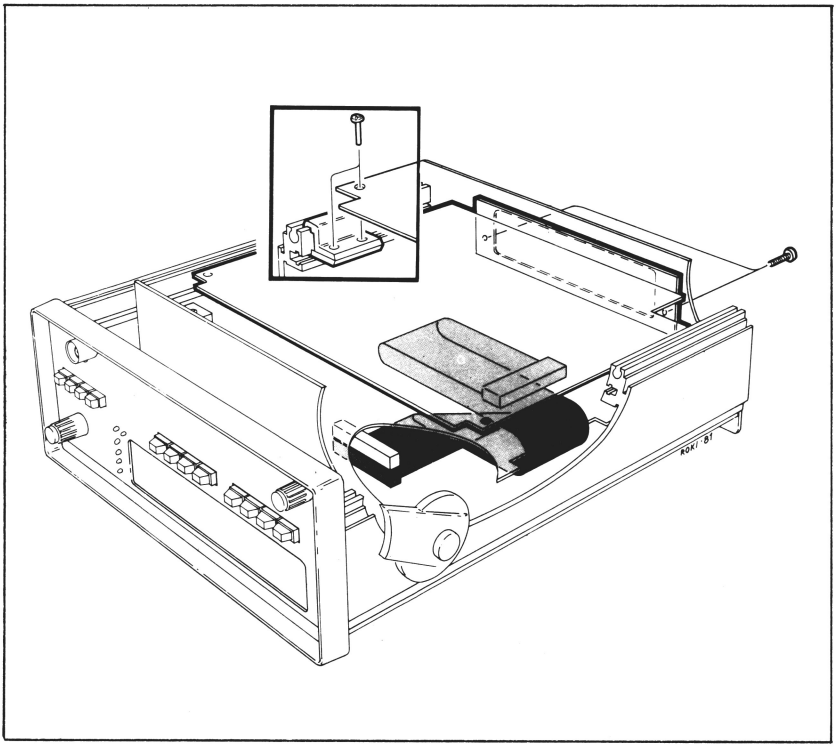


Fig. 4.1 Mounting the PM 9696

- Bend the brackets into two pieces. Fit the top and bottom piece of the brackets to each side of the counter frame.
- Fit one screw, but do not tighten. See Fig. 4.1.

- Hold the bus interface with its component side facing the soldering side of the counter main board, U1. Slip the ribbon cable free-end connector through the slot in U1.

- Fold the ribbon cable according to Fig. 4.1, so that the plastic foam pad rests on the soldering side of U1.

- Connect the ribbon cable free-end connector to pin connector BU101 on the component side of U1.

- Fit the bus interface with screws to the brackets, but do not tighten.

- Fasten the bus interface to the rear panel with two screws.

- Tighten all bracket screws.

- Refit the top and bottom cover of the counter.

- Attach the PM 9696 label to the rear panel to indicate that this option is installed, see Fig. 4.2.

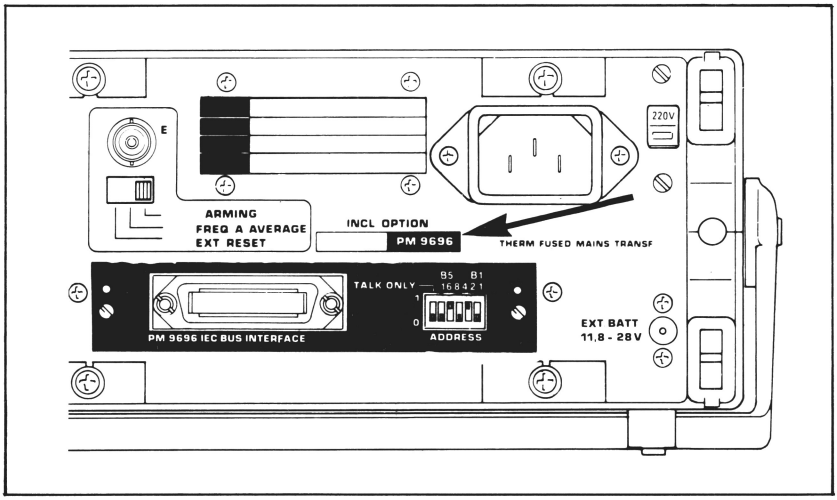


Fig. 4.2 Attach the PM 9696 label to the rear panel.

5. TROUBLE-SHOOTING

Symptom:

The counter cannot receive programming instructions from the controller.

Action:

1. Check bus-connectors.
2. Check address switch setting (factory preset to 10)
3. Check talk-only switch (should be Ø)
4. Check if there are un-powered devices connected to the bus.
5. Check software.

Symptom:

Output data from counter is not accepted by the controller.

Action:

1. Check that the output delimiter set is accepted by the controller. E.g. PET Commodore accepts CR, HP 85 accepts LF or CR+LF (default delimiter).
2. Check software regarding data formats.
3. Check TIME-OUT conditions. If your controller can be programmed for different TIME-OUT periods, a suitable period is max measuring time plus 1 s.

NOTE: The PET Commodore has a fixed time-out period of 64 ms for all bus transfers. This may cause trouble if not taken into account. See programming examples for further details.

6. PROGRAM EXAMPLES

The following programs demonstrate how any PM 6671...76 counter with a PM 9696 interface can communicate with a HP 9835/45, HP 85 or Commodore PET controller.

Program No. 1 will make any desirable number of frequency measurements and calculate the mean value, standard deviation and max/min values. This program will run on all PM 6671...76 counter models.

Program No. 2 is simpler and much shorter. Ten period measurements are made and only the mean value is calculated. The program is originally written for PM 6671 and PM 6672, but is easily modified for PM 6673...76.

Program No. 3 is written for HP 85 only. It illustrates how to implement the manual count function of a PM 6673...76 via the IEEE-488 bus.

The output string delimiter in PM 9696 interface should be set to LF (Line feed) when a HP 9835/45 or HP 85 controller is used and to CR (Carriage Return) when a Commodore PET is used.

The Commodore PET will wait only 64 ms for a bus data transfer to take place. After 64 ms a TIME OUT interrupt is issued. TIME OUT condition is recognized when the PET's interface status word (ST) =2. For this reason there is a special instruction (line 170) in the PET program listing.This instruction ensures that an input of measuring data will take place, independent of the actual input waiting time. HP 9835/45 and HP 85 have no restrictions on bus data transfer times.

If the counter will not communicate with the controller (e.g. operator cannot address the counter, gets no input data or cannot remotely program the counter) he must press the RESET pushbutton on the counter and try again. If the counter still doesn't communicate, check:

- The address switch on the rear panel. It must be set to 10 (binary 01010).
- The output string delimiter in the PM 9696 interface. It must be set to CR when a PET controller is used and should be set to LF when a HP controller is used.

Program No. 1

The number of samples, which must not exceed 1000, is given by the operator (INPUT statement). The counter is programmed to measure FREQ A (default value) with a 10 ms measuring time. The device address of the counter is 10.

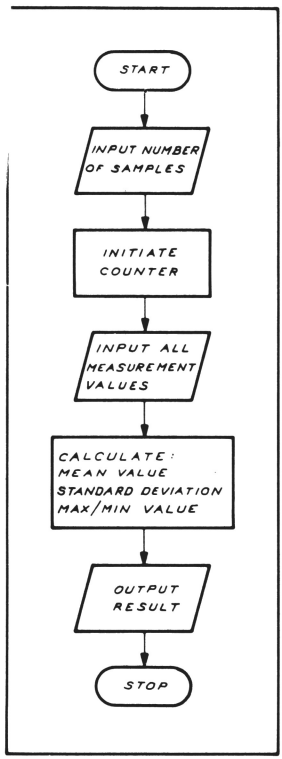


Fig. 6.1 Program No. 1 flow-chart.

HP 9835/45 program listing

```
10    ! **** IEC-BUS PROGRAM 1 FOR PM 6670-SERIES COUNTERS     ****
20    ! **** AND HP 9845/9835 AS CONTROLLER                    ****
30    !
40    PRINTER IS 0                    ! The built-in printer is used
50    PRINT
60    PRINT "FREQUENCY MEASUREMENTS WITH STATISTICS"   ! Head-line
70    PRINT
80    BEEP                            ! Wake-up signal
90    INPUT "HOW MANY SAMPLES ?",Nmax
100   CLEAR 710                       ! Clear and set default values
110   !                                 in PM9696 interface
120   OUTPUT 710;"M1E-2,X"            ! Set 10 ms meas. time and trigger
130   DIM A$(1000)                    ! Max 1000 samples is allowed
140   !
150   REM  Input all sample values ********************************
160   FOR N=1 TO Nmax
170   ENTER 710;A$(N)                 ! Device address is 10
180   NEXT N
190   !
200   REM  Calculate mean value ***********************************
210   M=0
220   FOR N=1 TO Nmax
230   M=M+VAL(A$(N)[4])
240   NEXT N
250   Mean=M/Nmax
260   !
270   REM   Calculate standard deviation **************************
280   S2=0
290   FOR N=1 TO Nmax
300   S2=S2+(Mean-VAL(A$(N)[4]))^2
310   NEXT N
320   !
330   REM   Calculate max and min values **************************
340   Max=VAL(A$(1)[4])
350   Min=VAL(A$(1)[4])
360   FOR N=2 TO Nmax
370   IF Max<VAL(A$(N)[4]) THEN Max=VAL(A$(N)[4])
380   IF Min>VAL(A$(N)[4]) THEN Min=VAL(A$(N)[4])
390   NEXT N
400   !
410   REM Output all parameters ***********************************
420   FIXED 0
430   PRINT "NUMBER OF SAMPLES =";Nmax
440   PRINT
450   IF Mean<100000 THEN FIXED 1          ! Select a
460   IF Mean<10000 THEN FIXED 2           ! suitable
470   IF Mean<1000 THEN FIXED 3            ! number of
480   IF Mean<100 THEN FIXED 4             ! decimals
490   IF Mean<10 THEN FIXED 5              ! for a nice-
500   IF Mean<1 THEN FIXED 6               ! looking output
510   PRINT "MEAN VALUE = ";Mean;" Hz"
520   PRINT
530   PRINT "STANDARD DEVIATION = ";SQR(S2/Nmax);" Hz"
540   PRINT
550   PRINT "MAX. VALUE = ",Max;" Hz"
560   PRINT "MIN. VALUE = ";Min;" Hz"
570   PRINT
580   END
```

HP 85 program listing

```
 10 !  IEC-BUS PROGRAM 1 FOR
 20 !  PM 6670-SERIES COUNTERS
 30 !  AND HP 85 AS CONTROLLER
 40 !
 50 PRINT
 60 PRINT "FREQUENCY MEASUREMENT
    S"
 70 PRINT
 80 CLEAR ! CLEAR DISPLAY SCREEN
 90 BEEP !  WAKE-UP SIGNAL
100 DISP "HOW MANY SAMPLES?"
110 INPUT Q
120 !  CLEAR AND SET DEFAULT
130 !  VALUES IN PM9696-INTER-
140 !  FACE
150 CLEAR 710
160 !  SET 10 ms MEASURING TIME
170 !  AND TRIGGER (X)
180 OUTPUT 710 ;"M1E-2,X"
190 DIM A(1000)
200 !  INPUT ALL SAMPLE VALUES
210 FOR N=1 TO Q
220 ENTER 710 ; A$
230 A(N)=VAL(A$[4])
240 NEXT N
250 !  CALCULATE MEAN VALUE
260 M=0
270 FOR N=1 TO Q
280 M=M+A(N)
290 NEXT N
300 M1=M/Q
310 !  CALCULATE ST. DEVIATION
320 S2=0
330 FOR N=1 TO Q
340 S2=S2+(M1-A(N))^2
350 NEXT N
360 !  CALCULATE MAX AND MIN
370 H=A(1)
380 L=A(1)
390 FOR N=2 TO Q
400 IF A(N)>H THEN H=A(N)
410 IF A(N)<L THEN L=A(N)
420 NEXT N
430 !  OUTPUT ALL PARAMETERS
440 PRINT "NUMBER OF SAMPLES=";Q
450 Y=1
460 IF M1<100000 THEN Y=10
470 IF M1<10000 THEN Y=100
480 IF M1<1000 THEN Y=1000
490 IF M1<100 THEN Y=10000
500 IF M1<10 THEN Y=100000
510 IF M1<1 THEN Y=1000000
520 PRINT "AVERAGE=";
530 PRINT INT(M1*Y)/Y;"Hz"
540 PRINT "ST. DEVIATION=";
550 PRINT INT(SQR(S2/Q)*Y)/Y;
560 PRINT "Hz"
570 PRINT "MAX VALUE=";H;"Hz"
580 PRINT "MIN VALUE=";L;"Hz"
590 END
```

Commodore PET program listing

```
 40 REM    SET OUTPUT STRING DELIMITER
 50 REM    IN PM9696 TO CR
 60 PRINT "FREQUENCY MEASUREMENTS"
 70 PRINT " "
 80 PRINT "HOW MANY SAMPLES?"
 90 INPUT Q
100 OPEN 66,10
110 PRINT #66, "D" : REM CLEAR PM 9696 INTERFACE
120 PRINT #66, "M.01X":REM SELECT 10MS MEAS.TIME
130 DIM A$ (1000)
140 REM INPUT ALL SAMPLE VALUES ****
150 FOR N=1 TO Q
160 INPUT #66, A$(N)
170 IF ST=2 THEN 160 :REM TIME-OUT CONDITION
180 NEXT N
190 REM CALCULATE MEAN VALUE ****
200 M=0
210 FOR N=1 TO Q
220 M=M+VAL(MID$(A$(N),4,16))
230 NEXT N
240 ME=M/Q
250 REM CALCULATE STANDARD DEVIATION ****
260 S2=0
270 FOR N=1 TO Q
280 S2=S2+(ME-VAL(MID$(A$(N),4,16)))^2
290 NEXT N
300 REM CALCULATE MAX. AND MIN. ****
310 MA = VAL(MID$(A$(1),4,16))
320 MI = MA
330 FOR N = 2 TO Q
340 X = VAL (MID$(A$(N),4,16))
350 IF MA   X THEN MA=X
360 IF MI   X THEN MI=X
370 NEXT N
380 REM OUTPUT ALL PARAMETERS ****
390 PRINT "NUMBER OF SAMPLES";Q
420 Y=1
430 IF ME   100000 THEN Y=10
440 IF ME    10000 THEN Y=100
450 IF ME     1000 THEN Y=1000
460 IF ME      100 THEN Y=10000
470 IF ME       10 THEN Y=100000
480 IF ME        1 THEN Y=1000000
490 PRINT "AVERAGE ="; INT(Y*ME)/Y
500 PRINT "ST.DEV=";INT(Y*SQR(S2/Q))/Y
510 PRINT "MAX VALUE=";MA
520 PRINT "MIN VALUE=";MI
530 END
```

Program No. 2

The device address of the counter is 10. The counter is programmed to measure PERIOD A with a 1s measuring time. The programs listed were originally written for PM 6671 and PM 6672 (Function code F13 for Period A measurements), but are easily modified for PM 6673...76 (Function code F10); see note below the program listings.

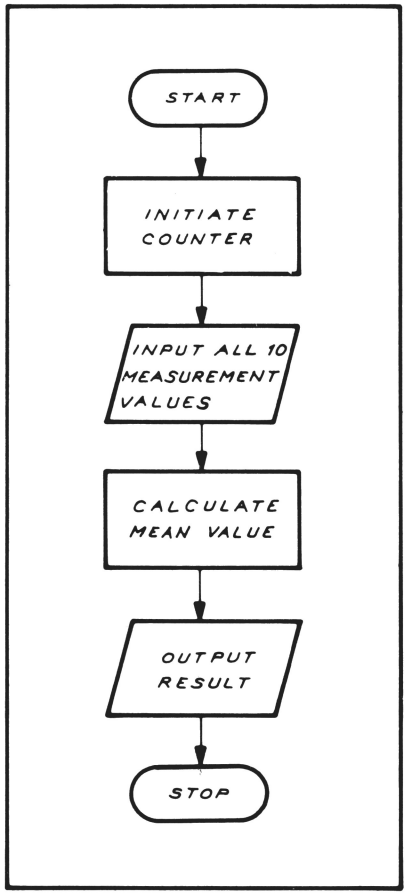


Fig. 6.2 Program No. 2 flow-chart.

HP 9835/45 program listing

```
10    ! ********************************************
20    ! ****     IEC-BUS PROGRAM 2 FOR PM 6671 OR     ****
30    ! ****     PM 6672 TIMER/COUNTER AND            ****
40    ! ****     HP 9835/45 AS CONTROLLER             ****
50    ! ********************************************
60    !
70    ! INITIATE COUNTER ********************************
80    !
90    CLEAR 710              ! RESET COUNTER
100   OUTPUT 710;"F13M1"     ! SELECT PERIOD A AND 1s MEAS  TIME
110   !
120   ! INPUT ALL SAMPLE VALUES  ************************
130   Z=0
140   FOR N=1 TO 10
150   TRIGGER 710            ! TRIGGER COUNTER
160   ENTER 710;A$           ! INPUT MEASUREMENT RESULT
170   Z=Z+VAL(A$[4])         ! CALCULATE SUM OF ALL 10 VALUES
180   NEXT N
190   ! CALCULATE MEAN VALUE  **************************
200   !
210   M=Z/10
220   ! PRINT RESULT ************************************
230   PRINT "AVERAGE =";M;"s"
240   END
```

HP 85 program listing

```
 10 !   IEC-BUS PROGRAM 2 FOR
 20 !   PM 6671 OR PM 6672
 30 !   TIMER/COUNTER AND
 40 !   HP 85 AS CONTROLLER
 50 !
 60 !   CLEAR COUNTER
 70 CLEAR 710
 80 !   SELECT PERIOD A (F13)
 90 !   AND 1s MEASURING TIME
100 OUTPUT 710 ;"F13M1"
110 !   INPUT ALL SAMPLE VALUES
120 Z=0
130 FOR N=1 TO 10
140 TRIGGER 710
150 ENTER 710 ; A$
160 Z=Z+VAL(A$[4])
170 NEXT N
180 !   GET MEAN VALUE
190 M=Z/10
200 !   DISPLAY MEAN VALUE
210 DISP "AVERAGE=";M;"s"
220 END
```

If a frequency counter PM 6673...76 is used instead of a timer/ counter PM 6671 or PM 6672, then change line 100 to:

```
100 OUTPUT 710; "F10M1"      !  SELECT PERIOD A
```

Applies to both HP 9835/45 and HP 85.

Commodore PET program listing

```
 60 REM    SET OUTPUT STRING DELIMITER
 70 REM    IN PM9696 TO CR
 80 DIM A$(20)
 90 OPEN 66,10
100 PRINT #66, "D"  :REM CLEAR PM 9696 INTERFACE
110 PRINT #66, "F13M1"   :REM SELECT PERIOD A AND 1S MEAS. TIME
120 REM INPUT ALL SAMPLE VALUES ****
130 Z=0
140 FOR N=1 TO 10
150 PRINT #66,"X"  :REM TRIGGER COUNTER
160 INPUT #66, A$  :REM INPUT MEASUREMENT RESULT
170 IF ST=2 THEN 160     :REM TIME-OUT CONDITION
180 Z=Z+VAL(MID$(A$,4,20)) :REM CALCULATE SUM OF ALL 10 VALUES
190 NEXT N
200 PRINT "AVERAGE ="; Z/10
210 END
```

If a frequency counter PM 6673...76 is used instead of a timer/ counter PM 6671 or PM 6672, then change line 110 to:

```
110 PRINT #66, "F10M1"     :REM  SELECT PERIOD A
```

Program No. 3

This program illustrates how the manual COUNT function in a PM 6673...76 counter can be remotely controlled via the IEEE-bus by a HP 85 controller. The counter has device address No. 10 and is connected to the IEEE-488 interface of the HP 85 (Interface channel No. 7).

Two examples are given. In the first example, the operator enters a given time (100 ms...27 min) for totalizing the number of events on Input A. In the second example, the operator defines the time interval by pressing the "END LINE" key to start totalizing and pressing it once more to stop the totalizing. To measure the actual elapsed time, the TIME function in HP 85 is used. The TIME function returns the number of seconds elapsed since Power ON (or initializing).

HP 85 program listing, example 1

```
 10 ! DEMONSTRATION PROGRAM #1
 20 ! CONTROLLING COUNT A
 30 ! FUNCTION VIA THE IEEE-BUS
 40 !
 50 CLEAR
 60 DISP "COUNT A MEASUREMENT"
 70 DISP "CHOOSE TIME INTERVAL (
    ms)"
 80 INPUT S
 90 ! PROGRAM THE COUNTER FOR
100 ! COUNT A MEASUREMENT (F0)
110 ! AND TRIGGER (X)
120 OUTPUT 710 ;"F0X"
130 T1=TIME
140 DISP "COUNT A STARTED"
150 ! 70 ms = APPROX. INTERNAL
160 ! DELAY TIME
170 WAIT S-70
180 ! INPUT MEASURING DATA =
190 ! =NUMBER OF COUNTS
200 ENTER 710 ; A$
210 T2=TIME
220 CLEAR 710
230 DISP "COUNT A STOPPED "
240 DISP
250 DISP "NUMBER OF COUNTS=";VAL
    (A$[4])
260 DISP
270 ! GET ELAPSED TIME (s)
280 ! WITH ONE DECIMAL
290 T=INT(10*(T2-T1))/10
300 DISP "ELAPSED TIME= ";T;"SEC
    ONDS"
310 END
```

HP 85 program listing, example 2

```
 10 ! DEMONSTRATION PROGRAM #2
 20 ! CONTROLLING COUNT A
 30 ! FUNCTION VIA THE IEEE-BUS
 40 !
 50 CLEAR
 60 DISP "COUNT A MEASUREMENT"
 70 DISP "PRESS 'END LINE' TO"
 80 DISP "START/STOP THE MEASURE
    MENT"
 90 INPUT S$ ! WAIT FOR INPUT
100 ! PROGRAM THE COUNTER FOR
110 ! COUNT A MEASUREMENT (F0)
120 ! AND TRIGGER COUNTER (X)
130 OUTPUT 710 ;"F0X"
135 ! GET STARTING TIME T1
140 T1=TIME
150 DISP "COUNT A STARTED"
160 INPUT S$ ! WAIT FOR INPUT
161 ! INPUT MEASURING DATA =
162 ! = NUMBER OF COUNTS
170 ENTER 710 ; A$
175 ! GET STOP TIME T2
180 T2=TIME
190 CLEAR 710
200 DISP "COUNT A STOPPED "
210 DISP
220 DISP "NUMBER OF COUNTS=";VAL
    (A$[4])
230 DISP
235 ! GET ELAPSED TIME (s)
236 ! WITH ONE DECIMAL
240 T=INT(10*(T2-T1))/10
250 DISP "ELAPSED TIME= ";T;"SEC
    ONDS"
260 END
```

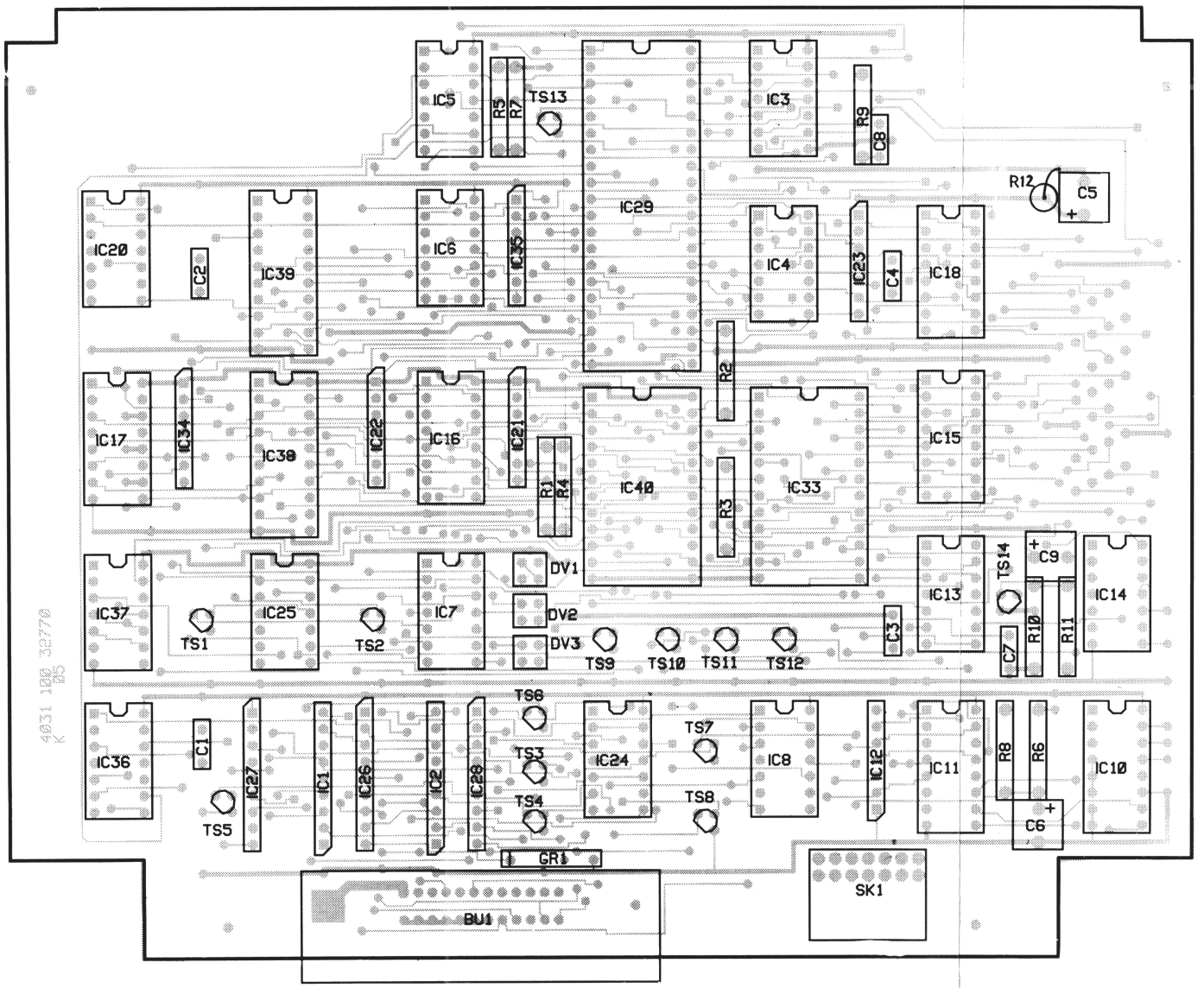
7. ISO CODING TABLE

ATN = Attention
GTL = Go To Local
SDC = Selective Device Clear
PPC = Parallel Poll Configure
GET = Group Execute Trigger
TCT = Take Control
LLO = Local Lock Out
DCL = Device Clear
PPU = Parallel Poll Unconfigure
SPE = Serial Poll Enable
SPD = Serial Poll Disable
UNL = Unlisten
UNT = Untalk

COLUMN →		0			1			2			3			4			5			6			7		
	b7 →	0			0			0			0			1			1			1			1		
	b6 →		0			0			1			1			0			0			1			1	
ROW	b5 →			0			1			0			1			0			1			0			1
↓	b4 b3 b2 b1 ↓	ISO-7 bit	dec equiv	ATN = 1	ISO-7 bit	dec equiv	ATN = 1	ISO-7 bit	dec equiv	ATN = 1	ISO-7 bit	dec equiv	ATN = 1	ISO-7 bit	dec equiv	ATN = 1	ISO-7 bit	dec equiv	ATN = 1	ISO-7 bit	dec equiv	ATN = 1	ISO-7 bit	dec equiv	ATN = 1
0	0 0 0 0	NUL	0		DLE	16		SP	32	0	0	48	16	@	64	0	P	80	16		96		p	112	
1	0 0 0 1	SOH	1	GTL	DC1	17	LLO	!	33	1	1	49	17	A	65	1	Q	81	17	a	97		q	113	
2	0 0 1 0	STX	2		DC2	18		"	34	2	2	50	18	B	66	2	R	82	18	b	98		r	114	
3	0 0 1 1	ETX	3		DC3	19		#	35	3	3	51	19	C	67	3	S	83	19	c	99		s	115	
4	0 1 0 0	EOT	4	SDC	DC4	20	DCL	$	36	4	4	52	20	D	68	4	T	84	20	d	100		t	116	
5	0 1 0 1	ENQ	5	PPC	NAK	21	PPU	%	37	5	5	53	21	E	69	5	U	85	21	e	101		u	117	
6	0 1 1 0	ACK	6		SYN	22		&	38	6	6	54	22	F	70	6	V	86	22	f	102		v	118	
7	0 1 1 1	BEL	7		ETB	23		'	39	7	7	55	23	G	71	7	W	87	23	g	103		w	119	
8	1 0 0 0	BS	8	GET	CAN	24	SPE	(	40	8	8	56	24	H	72	8	X	88	24	h	104		x	120	
9	1 0 0 1	HT	9	TCT	EM	25	SPD	)	41	9	9	57	25	I	73	9	Y	89	25	i	105		y	121	
10 A	1 0 1 0	LF	10		SUB	26		*	42	10	:	58	26	J	74	10	Z	90	26	j	106		z	122	
11 B	1 0 1 1	VT	11		ESC	27		+	43	11	;	59	27	K	75	11	[	91	27	k	107		{	123	
12 C	1 1 0 0	FF	12		FS	28		,	44	12	<	60	28	L	76	12	\	92	28	l	108		|	124	
13 D	1 1 0 1	CR	13		GS	29		–	45	13	=	61	29	M	77	13	]	93	29	m	109		}	125	
14 E	1 1 1 0	SO	14		RS	30		.	46	14	>	62	30	N	78	14	^	94	30	n	110		~	126	
15 F	1 1 1 1	SI	15		US	31		/	47	15	?	63	UNL	O	79	15	_	95	UNT	o	111		DEL	127	

ADDRESSSED COMMAND GROUP
UNIVERSAL COMMAND GROUP
LISTEN ADDRESS GROUP
TALK ADDRESS GROUP
SECONDARY ADDRESS GROUP

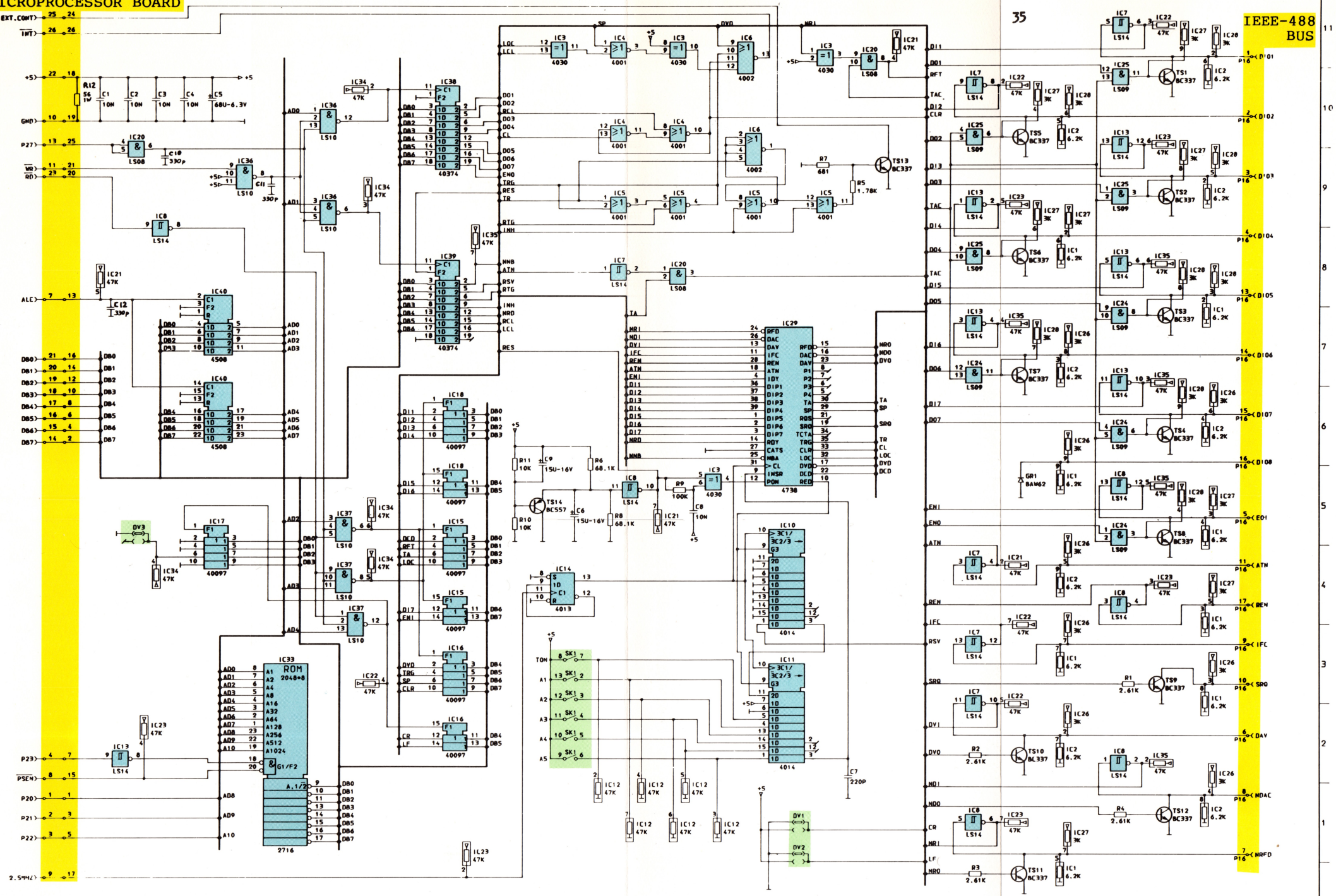
8. DIAGRAMS



Item	Pins	GND	+5V
IC3	14	7	2,14,8
IC4	14	7	14
IC5	14	7	14
IC6	14	7	14
IC7	14	7	14
IC8	14	7	14
IC10	16	4,5,6,7,8 11,13,14,15	16
IC11	16	6, 8	7, 16
IC13	14	7	14
IC14	14	7, 8, 10	14
IC15	16	8	16
IC16	16	8	16
IC17	16	2, 4, 8, 10	16
IC18	16	8	16
IC20	14	7	14
IC24	14	7	14
IC25	14	7	14
IC29	40	20, 27	40
IC33	24	12	24
IC36	14	7	10,11,14
IC37	14	7	14
IC38	20	1, 10	20
IC39	20	10, 18	20
IC40	24	1, 3, 12, 13, 15	24

MICROPROCESSOR BOARD

IEEE-488 BUS



9. SPARE PARTS LIST

Pos. No.	Order No.	Description	
BU1	5322 267 60148	Connector, IEEE-488 24 pol Bus conn.	
BU2	5322 321 21092	Cable Assy, 300 mm PM 9696-Microp. bd.	
C1..4	4822 122 31414	Capacitor, 10 nF -20/+50 %	100 V
C5	5322 124 10455	Capacitor, solid al. 68 µF ±20 %	6.3 V
C6	4822 124 20977	Capacitor, solid al. 15 µF ±20 %	16 V
C7	4822 122 30094	Capacitor, 220 pF ±10 %	100 V
C8 *)	4822 122 31414	Capacitor, 10 nF -20/+50 %	100 V
C9	4822 124 20977	Capacitor, solid al. 15 µF ±20 %	16 V
C10...C12	~~2222-851-12331~~	Capacitor, chip 330 pF	
DV1..3	5322 263 64007	Jumper connector, 2 pol FO88	
~~GR2~~	~~4822-130-21353~~	No longer used, improved reset circuit published in SPC58	
IC1, 2	5322 111 90737	Res. Network, 6.2 kohm ±5 %	1/8 W
IC3	5322 209 14124	IC CMOS, 4030B	
IC4, 5	4822 209 10246	IC CMOS, 4001	
IC5	5322 255 40419	IC-Socket, 14 pol	
IC6	4822 209 10293	IC CMOS, 4002B	
IC7, 8	5322 209 85199	IC TTL, 74LS14	
IC10, 11	4822 209 10296	IC CMOS, 4014B	
IC12	5322 111 94031	Res. Network, 47 kohm ±10 %	1/8 W
IC13	5322 209 85199	IC TTL, 74LS14	

*) Fitted on units with a metal-colored text-plate

NOTE: Overscored factory codes instead of order numbers means that no order No. is available at time of publication.

Example:

Pos. No.	Order No.	Description
C10...C12	~~2222-851-12331~~	Capacitor, chip 330 pF

Pos. No.	Order No.	Description	
IC14	4822 209 10248	IC CMOS, 4013B	
IC15..18	4822 209 10317	IC CMOS, 40097B	
IC20	5322 209 84995	IC TTL, 74LS08	
IC21..23	5322 111 94031	Res. Network, 47 kohm ±10 %	1/8 W
IC24, 26	5322 209 85801	IC TTL, 74LS09	
IC26..28	5322 111 90741	Res. Network, 3.0 kohm ±5 %	1/8 W
IC29	5322 209 14509	IC CMOS, 4738V	
IC29	5322 255 40422	IC-Socket, 40 pol DIL	
IC33 **)	5322 209 82853	IC, PM 9696 PROM	
IC33	5322 255 40421	IC-Socket, 24 pol DIL	
IC34, 35	5322 111 94031	Res. Network, 47 kohm ±10 %	1/8 W
IC36, 37	5322 209 84996	IC TTL, 74LS10	
IC38, 39	5322 209 10385	IC CMOS, 40374B	
IC40	5322 209 14559	IC CMOS, 5408B	
R1, 4	5322 116 50671	Resistor, 2.61 kohm ±1 %	MR25 0.4 W
R5	5322 116 50515	Resistor, 1.78 kohm ±1 %	MR25 0.4 W
R6	4822 116 51266	Resistor, 68.1 kohm ±1 %	MR25 0.4 W
R7	4822 116 51233	Resistor, 681 ohm ±1 %	MR25 0.4 W
R8	4822 116 51266	Resistor, 68.1 kohm ±1 %	MR25 0.4 W
R9 *)	4822 116 51268	Resistor, 100 kohm ±1 %	MR25 0.4 W
R10, 11 *)	4822 116 51253	Resistor, 10.0 kohm ±1 %	MR25 0.4 W
R12	5322 116 54929	Resistor, 56 ohm ±5 %	1.6 W
SK1	5322 277 10805	Dip Switch, 6 pol 206-006	
TS1..13	4822 130 40855	Transistor, NPN BC337	0.5 A 45 V
TS14 *)	4822 130 44256	Transistor, PNP BC557	0.1 A 45 V

*) Fitted on units with a metal-colored text-plate.

**) This PROM is only used by the PM 6670-series of counters. However, it can be installed in a PM 6652,-54 without causing trouble. The PROM is not fitted when PM 9696 is delivered with PM 6652,-54.

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Apartado Aereo 1841, Lima 100; tel. 51-14-326070

Philippines: Philips Industrial Development Inc.,
2246 Pasong Tamo,
Makati, Metro Manila; tel. 63-2-868951/868959

Portugal: Philips Portuguesa S.A.R.L.,
1009 Lisboa Codex, Av. Eng.° Duarte Pacheco 6, 1000 Lisboa;
tel. 351-1-683121/9
Service Centre:
Servicos Técnicos Profissionais, Outurela/Carnaxide, P.O.Box 55
2795 Linda-a-Velha; tel. 351-1-2180071

Saoudi Arabia: Delegate Office of Philips Industries,
Sabreen Bldg., Airport Road, P.O. Box 9844,
Riyadh; tel. 966-1-477808/4778463/4778216/4778335

Schweiz-Suisse-Svizzera: Philips A.G.,
Allmendstrasse 140, Postfach 670, CH-8027 Zürich;
tel. 41-1- 4882211

Singapore: Philips Project Development(S) Pte. Ltd.,
Lorong 1, Tao Payoh, 1st floor,
P.O. Box 340, Toa Payoh Central Post Office,
Singapore 9131; tel. 65-2538811

South Africa: South African Philips (Pty) Ltd.,
2 Herb Street, New Doornfontein, P.O.B. 7703,
Johannesburg 2000; tel. 27-11-6179111

South-Korea: Philips Electronics (Korea) Ltd.,
260-199, Itaewon-dong, Yongsan-ku,
C.P.O. Box 3680, Seoul; tel. 794 5011/5

Suomi: Oy Philips AB.,
Kaivokatu 8,
P.O. Box 255,
SF-00101 Helsinki 10; tel. 358-0-17271
Service Centre:
Sinikalliontie 1-3,
P.O. Box 11, SF-02630 Espoo;
tel. 358-0-523122

Sverige: Philips Försäljning AB,
Div. Industrielektronik, Tegeluddsvägen 1,
Fack, S11584 Stockholm; tel. 46-8-7821000

Syria: Philips Moyen-Orient S.A.R.L., Rue Fardoss 79,
B.P. 2442, Damas,
tel. 221650/218605/228003/221025

Taiwan: Philips Taiwan Ltd.,
150, Tun Hya North Road,
P.O. Box 22978, Taipei;
tel. 886-2-712-0500

Tanzania: Philips (Tanzania) Ltd.,
T.D.F.L. Building (1st floor), Ohio/Upanga Road
P.O. Box. 20104, Dar es Salaam; tel. 29571/4

Thailand: Philips Electrical Co. of Thailand Ltd.,
283 Silom Road, P.O. Box 961, Bangkok 10500;
tel. 66-2-2336330.9/2355665.8

Tunisia: S.T.I.E.T., 32 bis, Rue Ben Ghedhahem,
Tunis; tel. 216-1-348666

Türkiye: Türk Philips Ticaret A.S.,
Inönü Caddesi 78/80
Posta Kutusu 504, Beyoglu,
Istanbul ; tel. 90-1-1435910

United Arab Emirates: Philips Middle East B.V.,
Dubai International Trade Centre, Level 11,
P.O. Box 9269, Dubai; tel. 971-4-37700

United Kingdom: Pye Unicam Ltd., York Street,
Cambridge CB1 2PX; tel. 44-223-358866
Service Centre:
Pye Unicam Ltd.,
Service Division,
Beddington Lane,
Croydon CR9 4EN;
Tel.: 44-1-6843670

Uruguay: Industrias Philips del Uruguay S.A.,
Avda Uruguay 1287, Casilla de Correo 294,
Montevideo; tel. 915641/2/3/4-919009
Service 387777-387878-388484

U.S.A.:
Philips Test and Measurement Department Inc.,
California, Garden Grove 92645
12882 Valley View Street, Suite 9,
tel.: (213) 594-8741/(714) 898-5000
California, Milpitas 95035
477 Valley Way;
tel. (408) 946-6722
Florida, Winter Park 32789
1850 Lee Road, Suite 229;
tel. (305) 628-1717
Illinois, Itasca 60143
500 Park Blvd., Suite 1170,
tel. (312) 773-0616
Massachusetts, Woburn 01801
21 Olympia Avenue;
tel. (617) 935-3972
Minnesota, Minneapolis 55420
7851 Metro Parkway, Suite 302;
tel. (612) 854-2426
New Jersey, Mahwah 07430
85 McKee Drive;
tel. 1-201-5293800, Toll-free 800-6317172

Venezuela: Industrias Venezolanas Philips S.A.,
Av. Diego Cisneros, Edificio Centro Colgate,
Apartado Aereo 1167, Caracas 1010-A;
tel. 58-2-2393811/2392222/2393933

Zaire: S.A.M.E./s.a.r.l., 137, Boulevard du 30 juin,
B.P. 16636, Kinshasa;
tel. 31887-31888-31921

Zambia: Philips Electrical Zambia Ltd.,
Mwenbeshi Road, P.O.B. 31878, Lusaka;
tel. 218511/218701

Zimbabwe: Philips Electrical (Pvt) Ltd.,
62 Mutare Road, P.O. Box 994, Harare;
tel. 47211/48031

For information on change of address:
Philips Export B.V.,
Scientific and Industrial Equipment Division,
Test and Measurement, Building TQ III-4, P.O. Box 218,
5600 MD Eindhoven - The Netherlands
Tel. 31-40-784506

For countries not listed here:
Philips Export B.V., I&E Export,
Test and Measurement, Building HBS, P.O. Box 218,
5600 MD Eindhoven - The Netherlands;
Tel. 31-40-755546